Source process of the 2014 Northern Nagano earthquake

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An earthquake with JMA magnitude 6.7 occurred on 22 November, 2014, in the northern Nagano prefecture, Japan. This earthquake caused 46 casualties and damaged over 1500 housings. GCMT, F-net and JMA-CMT solution are coincide with each other and shows that a focal mechanism of this earthquake is reverse fault with some strike-slip components and about 20% non-DC component. Immediately after the earthquake, various institutions conducted field surveys and reported surface faults. Because the surface fault traces mostly matched with a known active fault named the Kamishiro fault, this fault is thought to be ruptured during the earthquake. The Kamishiro fault is located at the northern part of the Itoigawa-Shizuoka Tectonic Line which is one of the largest fault zones in Japan. It is important to investigate the source process of the earthquake. We performed a joint inversion of strong-motion and geodetic data to understand the source process of the earthquake.

In the northern Nagano region, there are dense strong-motion observation networks of K-NET, KiK-net, SK-net, and ERI. We used 45 components at 15 stations for the source inversion. All the waveforms were integrated to velocity, band-pass filtered between 0.02 - 0.4 Hz, and resampled with 0.25 s. For geodetic data, we chose 9 stations from GEONET. We used the daily coordinates of the F3 solution (Nakagawa et al., 2009) of GSI. To calculate static displacement by the earthquake, we set GEONET Shirotori as a reference point and then compared the mean value of 2-6 days before and after the earthquake. We used horizontal components and three components for GEONET Hakuba where significant vertical displacement was observed.

We used inversion methods of Yoshida et al. (1996) and Hikima and Koketsu (2005). Strong-motion Green's functions were calculated by the method of Kohketsu (1985) with one-dimensional velocity structure model based on the Japan Integrated Velocity Structure Model [JIVSM] (Koketsu et al., 2008, 2012) for each station. Geodetic Green's functions were calculated by the method of Zhu and Rivera (2002). In this calculation, a one dimensional velocity structure model beneath the GEONET Hakuba was extracted from the JIVSM and used for all the stations. We divided the faults into 13 x 7 subfaults and set strike and dip angles considering the surface faults and aftershock distributions. Each subfault has a size of 2 km x 2 km with a point source at the center with rake angle of 45 ± 45 to represent from reverse to left-lateral strike-slip faulting.

We obtained largest slip located at the north-eastern deeper part of the hypocenter. The shallower part has also some slips with maximum at near GEONET Hakuba. This slip area coincides with the observed largest surface displacement point. However, the focal mechanism calculated by summing up obtained slip vectors cannot explain the non-DC component, suggesting further investigation needed.

Keywords: 2014 Northern Nagano earthquake, source process, source inversion